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Thamnophis radix

Albert G. Smith

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The Subspecies of the Plains Garter Snake, *Thamnophis radix*

Albert G. Smith*

The garter snake, *Thamnophis radix* (Baird and Girard), ranges from the Wyoming Basin eastward through the Great Plains into the eastern part of the Central Lowlands. Such a widely distributed species naturally exhibits considerable variation. Earlier workers described three "color forms" under names which Cope (1900) synonymized with *radix* since, in his opinion at that time, they were not sufficiently different to deserve distinction as subspecies. These were *Eutaenia haydenii* Kennicott (1860), South Dakota; *Eutaenia radix twiningii* Coues and Yarrow (1878), Montana; and *Eutaenia radix melanotaenia* Cope (1888), Indiana. Cope also described *E. butleri* (1889), Indiana, and *E. brachystoma* (1892), Pennsylvania, which have been regarded as separate species by most authors during recent years, although their affinities with *radix* were recognized and Blanchard (1925) considered *butleri* a subspecies of *radix*.

My investigations of this group have led to the conclusion that the species *radix*, on the basis of morphological characters, is divisible into four subspecies: *Thamnophis radix radix*, *T. r. haydenii*, *T. r. butleri*, and *T. r. brachystoma*. The name *haydenii* is applied to the western subspecies.

Thamnophis radix haydenii (Kennicott)

Eutaenia haydenii, 1860, KENNICOTT, Rep. U. S. Pac. R. R. Surv., vol. 12, book 2, pt. 3, no. 4, p. 298, pl. 14.

Eutaenia radix twiningii, 1878, COUES AND YARROW, Bull. U. S. Geol. Surv. Terr., vol. 4, art. 11, p. 279-280.

Type Specimen. U.S. National Museum 707, collected by Dr. Evans (?) at Fort Pierre in Nebraska. This locality is now in Stanley County, South Dakota.

*Contribution of the Department of Biological Sciences, Loyola University, Chicago.

Original Description. "Sp. ch.--Head broader and more depressed in front than in *E. radix*. Form stout, compact, and cylindrical, most so of the genus, except *E. radix*. Ground color light olive green, with three longitudinal yellow stripes, and six series of distinct black spots. In life some red coloring visible on the sides. Lateral stripe on third and fourth rows less sharply defined than in *E. radix*. Dorsal rows, 21."

Taxonomic History. Cope (1900, p. 1089) considered both *haydenii* and *twiningii* as color variants, and synonymized these names under *radix*. Ruthven (1908, p. 70) followed Cope in this procedure but commented on the higher number of ventrals in western specimens. The subspecies *twiningii* of Coues and Yarrow is not sufficiently distinct from *haydenii* to be recognized separately, but in all characters falls within the expected range of the characters of *haydenii*.

Lectotypes. The condition of the original type is such that no complete examination can be made of it. At my request, both Dr. Doris M. Cochran and Dr. H. K. Gloyd, separately examined the type, but could not get any definitive counts or measurements. Dr. Gloyd informed me that the specimen is falling apart and Dr. Cochran, after detailing in a letter the mutilated condition of the type, suggested that a lectotype be designated. Accordingly the following series of specimens from South Dakota in the Chicago Academy of Sciences, all collected by H. K. Gloyd and T. I. Wright from areas near the type locality, are designated as "paralectotypes":

14498, Whitlock Crossing, Dewey County

14499, 6 miles west of Thatcher, Dewey County

14500, La Plant, Dewey County

13858, 3 miles southeast of Emory, McCook County.

Through the courtesy of the Chicago Academy of Sciences, numbers 144989 have been sent as a gift to the United States National Museum and 14498 may be considered as the lectotype.

Color. There are three stripes on a light brownish olive ground color. Anteriorly, the lateral stripe occupies the whole of the third and fourth row of scales on each side, narrowing posteriorly to the third and a small portion of the fourth row. In life this stripe is grayish, slightly tinted with yellow. The dorsal stripe occupies the vertebral (11th) row and one-half of each adjacent scale row; it is orange-yellow in life. Two parietal spots, one on each side of the parietal suture, are present, each of a slightly lighter shade than the dorsal stripe. There are two rows of dark chestnut-brown blotches, alternating with each other between the dorsal and lateral stripes. These blotches are largest anteriorly, being three scales high by one and one-half scales wide. Another row of chestnut-brown spots is present between the lateral stripes and

the ventral scales. The color of the belly varies from an unspotted whitish chin and neck to a slightly greenish color posteriorly. There is a series of small black elongated crescents on the lateral edges of the ventrals, mostly on the posterior half of the body. The under surface of the tail is heavily mottled with black.

Variation. A series of **794** specimens has been examined from all parts of the range; of these **393** were adult males and **80** were juvenile males, and **271** were adult females and **50** were juvenile females. The variable characters of this and the following subspecies have been analyzed statistically, and it is planned to present these analyses in a subsequent paper on the *radix* group of *Thamnophis*.

The dorsal scales are arranged in **21-21-19-17** rows in **520** (**78.4** per cent) specimens; in **19-21-19-17** rows in **132** (**20** per cent); and in **23-21-19-17** rows in **11** (**1.7** per cent) (see Table I). No specimens of *haydenii* were found to have a pattern of **19-19-17**, the arrangement typical of *butleri*.

The ventrals in **300** males vary from **140** to **175** (mean **162**) and in **245** females from **139** to **174** (mean **157**). The greater number of specimens (**85** per cent) have a higher number of ventrals than the mean (**154**) of *radix* (see Table II). The subcaudals of **275** males range from **69** to **88** (mean **78**), and of **233** females from **58** to **74** (mean **67**). The mean subcaudal count of *radix* is **75** in males and **65** in females.

The upper labial scales number seven on each side, although eight scales on each side are found in **40** per cent of the specimens; the lower labials number nine on each side, although 10 lower labials are found more frequently (**25** per cent) in *haydenii* than in *radix* (**11** per cent).

The tail/total length ratio of the **275** males varied from **.205** to **.278** per cent (mean **.253**), and of **233** females from **.205** to **.275** per cent (mean **.232**). The largest male examined was UMMZ **76521** [3rd] from near Kaodka, Jackson County, South Dakota, which measured **853** mm. in total length, tail length, **192** mm. The largest female, UMMZ **55644**, from Lake Okoboji, Dickinson County, Iowa, measured **1045** mm. in total length, tail length **213** mm.

The dorsal blotches between the stripes average **93** in *haydenii* while in *radix* the average number is **84**. The blotches are largest anteriorly in both subspecies, in *haydenii* normally three scales high by one and one-half wide, in *radix* from one-half to one scale larger in each direction.

The color of the dorsal stripe in both subspecies is variable, although generally the dorsal stripe is more orange-yellowish in *haydenii*. No real color differences in the lateral stripes are noticeable. Some Oklahoma specimens of *haydenii* exhibit a temporal crescent similar to that of *marcianus*, although it is not as well defined.

TABLE I

Variation in Scale Rows in the Subspecies of *Thamnophis radix* Expressed as a Percentage of the Total Number of Each Subspecies.

Number of scale rows	<i>haydenii</i>	<i>radix</i>	<i>butleri</i>	<i>brachystoma</i>
17-17-15	-	-	00.03	99.75
17-19-17		-	00.29	00.21
19-19-17	-	22.10	99.68	00.04
19-21-19-17	19.90	76.00	--	-
21-21-19-17	78.40	1.77		
23-21-19-17	1.70	0.13		

TABLE II

Variation in the Ventral and Subcaudal Scales and the Tail/Total Length Ratio in the Subspecies of *Thamnophis radix*.

	<i>Males</i>			<i>Females</i>		
	No.	Extremes	Mean	No.	Extremes	Mean
VENTRALS						
<i>haydenii</i>	300	140-175	162.1	245	139-174	157.2
<i>radix</i>	423	138-175	157	436	135-174	151
<i>butleri</i>	124	132-147	140.4	104	129-147	137.9
<i>brachystoma</i>	117	134-146	140	107	132-146	139
SUBCAUDALS						
<i>haydenii</i>	275	69-88	78	233	58-74	67
<i>radix</i>	421	67-88	75	400	54-74	65
<i>butleri</i>	106	57-71	64	97	51-63	56
<i>brachystoma</i>	103	57-72	67	98	51-64	59
TAIL/TOTAL LENGTH RATIO						
<i>haydenii</i>	275	.205-.278	.253	233	.205-.275	.232
<i>radix</i>	230	.207-.275	.235	211	.176-.247	.214
<i>butleri</i>	106	.215-.282	.248	97	.193-.244	.216
<i>brachystoma</i>	103	.207-.282	.252	98	.198-.246	.227

Range. *Thamnophis radix haydenii* occurs in the Great Plains from Minnesota south through western Iowa, Kansas, and the Oklahoma Panhandle, west into the foothills of the Rocky Mountains, and north into the southern portion of the Plains of Canada (Fig. 1, p. 291).

*Material Examined.** (Names of counties in *italics*)

CANADA. ALBERTA: Richdale, ROMZ 2396-7, 2502; Richmond, ROMZ 2500; Rose Lynn, ROMZ 2501; Veteran, ROMZ 1459. MANITOBA: Winnipeg, ROMZ 2607; Lake Winnipeg, USNM 9251. SASKATCHEWAN: Indian Head, ROMZ 4442; Lumsden Beach, ROMZ 3213-4; Melville, ROMZ 3175-6; Regina, USNM 22404.

COLORADO: Arapahoe—Deertrail, UMMZ 67402, 67436; Englewood, UMMZ 43878. Boulder—Boulder, AMNH 17287. Denver—Denver, USNM 15794. El Paso—Colorado Springs, AMNH 4219-20, 4239, 66542-3, 68709-13; Valmont, AMNH 4215, 4221-35, 4249. Fremont—Canon City, CA 904. Larimer—Fort Collins, UMMZ 46590-7. Prowers—Lamar, UMMZ 62441-3. Pueblo—Pueblo, USNM 8581. Weld—Laird, CNHM 38122,

IOWA: Adair—Greenfield, RMB. Audubon—Brayton, ISC 69; Kimballton, RMB. Boone—Pilot Mound, UMMZ 92947. Buena Vista—Alta, Newell, RMB. Calhoun—Twin Lake, UMMZ. t Carroll—Swan Lake State Park, ISC 824. Cass—Lyman, ISC 694; Atlantic, UMMZ 92953, 12964. Cherokee—Holstein, UMMZ 92959. Clay—Lost Island Lake, UMMZ 35093-4, 35098-124; Spencer, UMMZ 92956, 35132-3, 35172; Webb, UMMZ 35175, 35178. Crawford—Vail, RMB. Dallas—Minburn, UMMZ 92948. Dickinson—Arnold Peak, CNHM 35509; Center Grove Twp., UMMZ 55175, 55180, 55639, 55641-2; Lake Okoboji, CM 21702-3, UMMZ 55648-54, 55657-8, 55660, 89661; Milford, UMMZ 55163-74, 55176-9; Spirit Lake, UMMZ 55666-7, 92938-9, 92949. Emmett—Dolliver, UMMZ 92950. Fremont—Bartlett, ISC 717. Greene—Boxholm, ISC 767; Jefferson, RMB. Guthrie—Bagley, RMB. Harrison—Yorkshire, ISC 709. Humboldt—Humboldt, UMMZ 60166. Ida—Holstein, RMB. Kossuth—Lakota, RMB. Lucas—Chariton, UMMZ 92962. Mills—Council Bluffs, ISC 721-2. Monona—Onawa, UMMZ 92966. Montgomery—Grant, RMB. O'Brien—Calumet, UMMZ 92954. Osceola—Rush Lake, CM 21694. Palo Alto—Ruthven, UMMZ 35154-75, 31376. Plymouth—Hinton, ISC 699. Pocahontas—Fonda, RMB. Polk—Des Moines, USNM 14761, 45586. Pottawattamie—Council Bluffs, RMB. Sac—Lake View, RMB. Shelby—Harlan, RMB. Union—Creston, RMB. Wayne—Corydon, ISC 723. Webster—ISC 712. Woodbury—Luton, UMMZ 92946; Sloan, UMMZ 60167 (5). Wright—Solberg, RMB.

*The following abbreviations are used in the text to designate collections:

AGS, Albert G. Smith; AMNH, American Museum of Natural History; ANSP, Academy of Natural Sciences, Philadelphia; CA, Chicago Academy of Sciences; CM, Carnegie Museum; CNHM, Chicago Natural History Museum; ISC, Iowa State College; KU, University of Kansas Museum; MMNH, Minnesota Museum of Natural History; MPM, Milwaukee Public Museum; OSM, Ohio State Museum; UMMZ, University of Michigan Museum of Zoology; UOMZ, University of Oklahoma Museum of Zoology; USNM, United States National Museum; RMB, Reeve M. Bailey; ROMZ, Royal Ontario Museum of Zoology.

to series of 27, not catalogued when examined.

KANSAS: Barton—UMMZ 67037. *Cheyenne*—St. Francis, USNM 86916, KU 20303, 20918-23. *Cloud*—KU 2043. Coffey—Winfield, USNM 90572; Neosho River, KU 1997, 2028, 2031, 2044-7. Dickinson—Herington, USNM 90571. *Douglas*—KU 2103-4, 2129, 15499, 17416, 18498, 18500-8, 19607; Haskell Bottoms, KU 17418; Haskell Institute, KU 2010; Kansas University Campus, KU 2077-8, 2086; Lawrence, KU 2027, 2029, 2058, 7558, 19288-291, 19605-6, 20004. Finney—Holcomb, USNM 86927. *Franklin*—CM 8668, 8684, CNHM 18148-50, UMMZ 67038; Wellsville, USNM 89180. Geary—Fort Riley, USNM 5486. Gove—KU 2100. Gray—Ingalls, KU 21425. *Hamilton*—Coolidge, KU 20316. Harper—Harper, KU 17903; Hunter, KU 3052. *Harvey*—Halstead, KU 2041. Kearny—Deerfield, USNM 86926. Kingman—Norwich KU 17918. Lane—Pendennis, KU 3612-4 (5); 3721. Logan—Vincent Ranch, KU 20311. *Marion*—Lincolnville, KU 23602. *Marshall*—Irving, CNHM 18153. *McPherson*—USNM 89178. *Meade*—Meade, AMNH 62846-7, KU 5436, 5440, 5442-3; Meade State Park, UMMZ 88486, 91526, KU 21861. Morton—Spring Creek, KU 2567-77; Elkhart, KU 3566-7, 3611, 5437-9, 5444-5. *Osborne*—KU 2082-4. Rawlins—McDonald, KU 2034, 14135. Republic—KU 2126. Rice—UMMZ 67375. Riley—Manhattan, USNM 89179, AMNH 36893. *Rooks*—KU 2105. *Russell*—KU 2023, Republican River, USNM 655. *Scott*—Scott County State Park, UMMZ 75629. Sherman—Goodland, KU 20292-5. *Stafford*—Little Salt Marsh, UMMZ 67373, USNM 73332, KU 2025, 3609. Thomas—Rexford, UMMZ 67374. *Trego*—KU 1995, 2081, 2094, 2098, 2699, 3700, USNM 56270; Collyer, KU 3610. *Wallace*—KU 2011, Rhino Hill Quarry, KU 14134, 15697, 17170-1; Sharon Springs, KU 14136.

MINNESOTA: *Anoka*—MMNH 809; Johnsville, MMNH 890. Brown—Sleepy Eye, MMNH 147. Clay—Barnesville, MMNH 844; Hitterdal, MMNH 551; Syre, MMNH 552. Clearwater—Itasca State Park, CM 20529. *Cottonwood*—Des Moines River, MMNH 940. *Dakota*—Rosemont, MMNH 874. *Faribault*—Aldemn, MMNH 819. *Fillmore*—MMNH 816. *Hennepin*—MMNH 344-5; Minneapolis, AMNH 64608, 3260, 3262; Fort Snelling, USNM 32048-50. *Jackson*—Heron Lake, MMNH 148, 942-3. *Mahnomen*—Waubun, CM 20588. *Nicollet*—Swan Lake, MMNH 937. *Ramsey*—St. Paul, MMNH 319. Rice—Faribault, MMNH 323. *Scott*—Jordan, MMNH 757. *Sherburne*—Elk River, MMNH 998. *Steele*—Owatonna, MMNH 857. *Yellow Medicine*—MMNH 963; Granite Falls, MMNH 954.

MONTANA: Carter—Alzada, UMMZ 92788 (3); Capitol, USNM 54725. *Cascade*—*Cascade*, CA 3608; Great Falls, USNM 44228. *Chouteau*—Fort Benton, USNM 712. Custer—Miles City, USNM 61621, UMMZ 46568, 76495, 92787. *Dawson*—Jordan, UMMZ 49820; Glendive, USNM 54443. *Prairie*—Terry, USNM 61618. *Valley*—Glasgow, USNM 62531. The following localities are not exactly placeable: Frenchman's Creek, USNM 9540-1; Milk River, USNM 698, 714, 716; Mouse River, USNM 9531; Yellowstone River, USNM 703-4, 711, 11478.

NEBRASKA: Antelope—Brunswick, UMMZ 67403. *Brown*—Ainsworth, CNHM 19237; Long Pine, AMNH 4929. Buffalo—Fort Kearney, USNM 658, 665, 45584. *Cherry*—Kennedy, USNM 44298; Merriman, AMNH 37058. *Dakota*—Jackson, UMMZ 67404. *Dawes*—Chadron, USNM 21270. *Lincoln*—Forks of Platte River, USNM 21537. *Merrick*—Central City, USNM 118451-2. *Pierce*—Hadar, USNM 83965. *Scotts Bluff*—Morrill, UMMZ 71662. Sheridan—Lakeside, UMMZ 71661; Antioch, UMMZ 79700; Ellsworth, UMMZ 71663; Gordon, AMNH 36804. *Sherman*—Loup City, UMMZ 3703. Thayer—Hebron, AMNH 36736-7. *Valley*—Ord, AMNH 36734. The following are

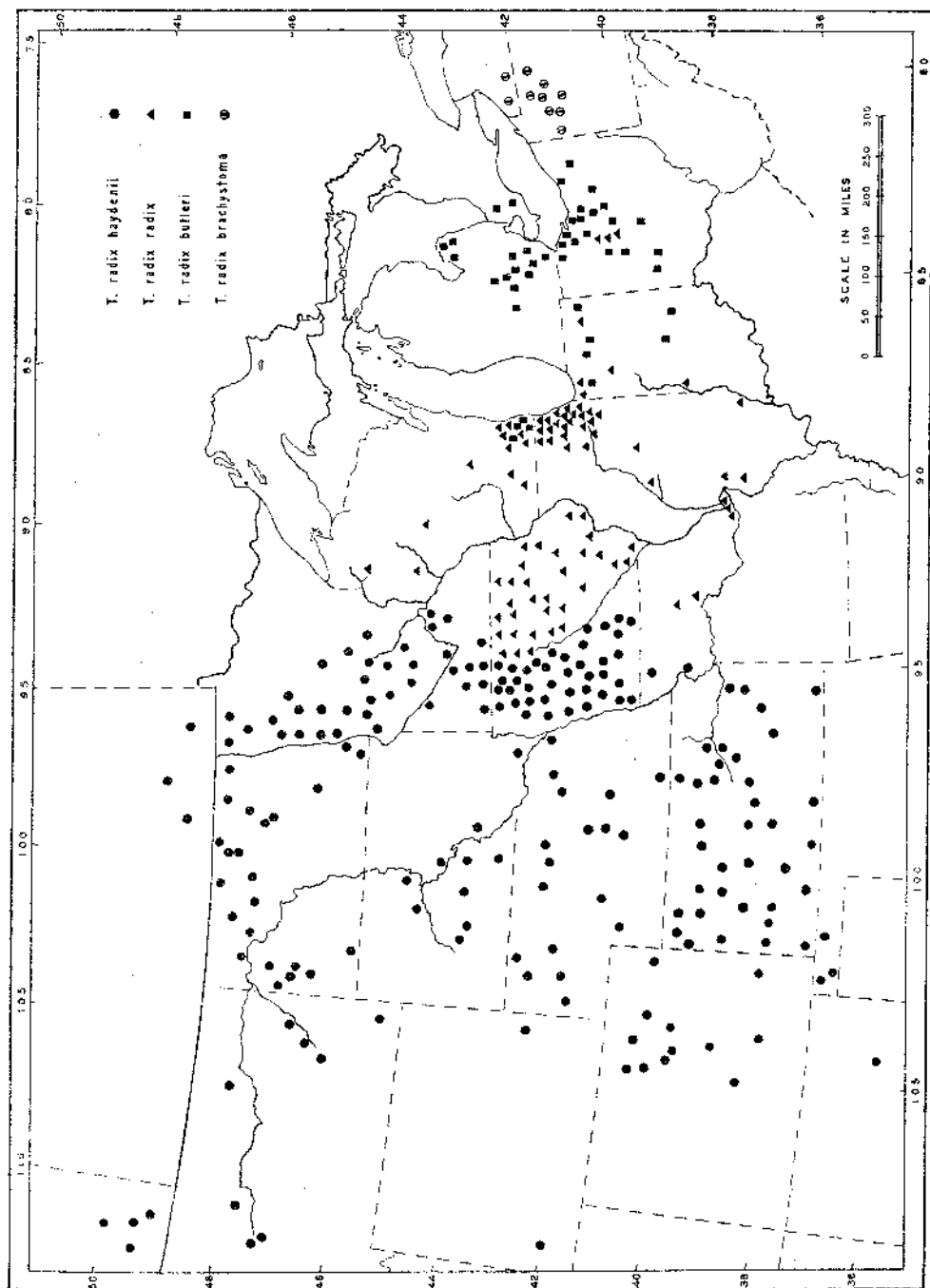


Figure 1. Geographic distribution of the subspecies of *Thamnophis radix*. Based on specimens examined by the writer.

not exactly placeable: Platte River, USNM 650, 660, 662, 666; South Platte River, USNM 612

NEW MEXICO: Mora—Fort Union, USNM 86921-5. *San Miguel*—Las Vegas, UOMZ 25224-7.

NORTH DAKOTA: Adams—Hettinger, UMMZ 65061. *Barnes*—Valley City, USNM 66616. *Benson*—Spring Lake, USNM 53072. *Billings*—Medora, UMMZ 54465, 56906-9. *Bottineau*—Bottineau, UMMZ 53803-5. *Cavalier*—Langdon, UMMZ 90202. *Eddy*—Warwick, UMMZ 54469. *Grand Forks*—Larimore, USNM 53037. *McHenry*—Towner, USNM 53036. *McKenzie*—Goodall, USNM 53038; Junction of Missouri and Yellowstone Rivers, USNM 695, 700, 710. *Mountrail*—Lostwood, USNM 53073. *Nelson*—Stump Lake, UMMZ 54467-8, 54471-2. *Pembina*—Pembina, USNM 9528-30, 9535-6. *Ramsey*—Devil's Lake, USNM 38082-3, 54466. *Richland*—Hankinson, USNM 49601; Wahpeton, USNM 53030. *Rollete*—Fish Lake, USNM 49589; Lake Upsilon, UMMZ 54470. *Ward*—Kenmare, USNM 50002. *Williams*—Buford, UMMZ 65289-90; Grinnell, USNM 53033-4.

OKLAHOMA: Cimarron—Cimarron, UMMZ 77562; Black Mesa, near Kenton, UOMZ 4930, 4937, 4941, 4943-4, 4947, 4950-3, 5140-9, 5170-3, 5233-8; State Monument, UMMZ 63517. Texas—Coldwater Creek, UOMZ 4842.

SOUTH DAKOTA: Brule—Pukwana, AMNH 36802-3. Clay—Vermilion, UMMZ 44692. Dewey—Thatcher, CA 14499; LaPlant, CA 14500; Whitlock Crossing, CA 14498. *Hughes*—Fort Pierre, USNM 707 (Type). Jackson—Kadoka, UMMZ 76519-28 (25); Belvidere, UMMZ 71678. *Jones*—Draper, AMNH 36805. Lyman—Reliance, AMNH 36782-9, CM 5145-6. McCook—Emory, CA 13858. *Tripp*—Dog Ear Lake, UMMZ 78118.

WYOMING: Goshen—Rawhide Butte, CNHM 1893. *Lincoln*—Jackson, UMMZ 65273 (2).

Thamnophis radix radix (Baird and Girard)

Eutaenia radix, 1853, **BAIRD AND GIRARD**, Cat. North Amer. Reptiles, pt. I, Serpents, p. 34.

Eutaenia radix melanotaenia, 1888, **COPE**, Proc. U. S. Nat. Mus., vol. 11, p. 400.

Thamnophis radix, 1899, **JORDAN**, Manual Vert. Animals, North Amer., 8th ed., P-193; 1908, **RUTHVEN**, Bull. U. S. Nat. Mus., no. 61, p. 70.

Thamnophis radix radix, 1925, **BLANCHARD**, Papers Michigan Acad. Science, Arts and Letters, vol. 4, (1924), pt. 2, p. 18.

Diagnosis. A garter snake with 19 scale rows at the neck and 21 at midbody, and in which the ventral scales are usually 154 or less in number.

Type Specimen. United States National Museum 719, taken at Racine County, Wisconsin, by Dr. P. R. Hoy.

Description. The ground color varies from dark olive to dark brown. One dorsal and two lateral stripes are present; the lateral stripes are on the third and fourth scale rows, and the dorsal occupies the vertebral and one-half of each adjacent scale row. There are two rows of alternating blotches, larger than those of *haydenii* but not as numerous, between the lateral and dorsal

stripes; and another row of blotches on each side between the lateral stripes and the ventral scales. Parietal spots are usually present.

The scales are normally arranged in a pattern of 19-21-19-17 rows (76 per cent, Table I). Some Illinois specimens exhibit an arrangement of 19-19-17 rows, the typical pattern of *butleri*. Twelve of 860 specimens have 23 scale rows at the neck.

The ventrals in 423 males vary from 138 to 175 (mean 157), and in 436 females from 135 to 174 (mean 151). In 421 males the subcaudals range from 67 to 83 (mean 75), and in 400 females from 54 to 74 (mean 65).

The upper labials are seven on each side, and there are normally nine lower labials. Specimens with eight or seven-eight upper labials, and some with ten lower labials are frequently found. Seventeen have 10-11 lower labials and one has 11 lower labials on each side. Preoculars are one on each side, and the postoculars are three on each side. The temporal scales are normally 1---2-3, but a formula of 1 2_____2 or of 1 1____2 is frequently found.

The tail/total length ratio in 230 males ranged from .207 to .279 (mean .235), and in 211 females from .176 to .247 (mean .214). The largest male, CNHM 2107, from Miller, Lake County, Indiana, measured 745 mm. in total length, tail length 170 mm. The largest female, CA 8031, from Sumner, Chariton County, Missouri, measured 845 mm. in total length, tail length 170 mm.

Definite intergrades between *radix* and *haydenii* have been seen from areas adjacent to the Des Moines River in Iowa. It is probable that intergradation occurs in northern Minnesota also. The various characters of scutellation in the eastern part of the range of *haydenii* grade into those of *radix*.

Range. This subspecies occurs in the Prairie Peninsula and its "islands" in Indiana and Ohio, and from Wisconsin south through Illinois and eastern Iowa into Missouri (Fig. 1, p. 291). Its distribution seems correlated mostly with the young and submature till plains, and it invades the older plateaus only on the periphery of its range.

Material Examined. (Names of counties in *italics*)

ILLINOIS: Cook-Argo, CNHM 3317, 21801; Berwyn, CNHM 776, 1440, 2126, 2699; Blue Island, CNHM 16066-7, 30420; Braeside, CNHM 15679, 15704, 16055; Chicago CA 1424-30, 1849, 4309, 4405, 7753-70, 7771, 7775-96, CNHM 90, 497, 536, 1435-8, 1444, 2438, 2962, 8281, 3092, 3330, 16068-71, 17034-9, 17611-4, 17633-42, 11213-4, 11216-20, 3058, 22668-70, 29421-2, 31506-20, 26020-30, 29410, 29418, 28260-9, 33892, 39392, 38033; Deerfield, CNHM 17703-5, 33880, 31942; Dunning, CA 11020-57; Edgebrook, CA 911; Evanston, CNHM 25301, 38032; Flossmoor, OSM 527, 632-3; Forest Park, CNHM 3091; Highland Park, CNHM 26302; Homewood, CNHM 8059, 8289, 8469, 8747. 8935. 6418. 6453. 6906. 7792-3. 7826-34. 16053-4. 22858. 22903. 21747-54. 31764-7.

28294; Kenilworth, CNHM 641; La Grange, CNHM 25981; Melrose Park, CA 7749-52; Pullman, CNHM 1931; Riverdale, CNHM 648; River Forest, CNHM 25438, 16059-65, 3343, 3248, 21817-8; Schiller Park Forest Preserve, CA 6884-5; Summit, CNHM 21256-7; Wolf Lake, CNHM 15563-4. DeKalb—Sycamore, UMMZ 46589; DuPage—Bensenville, CA 6052-78; DuPage River, CNHM 7450; Glen Ellyn, UMMZ 46564-74, 46589; Hinsdale, CNHM 37214, 29132-8; Lombard, CNHM 3331, 21812-4, 35485, 3286-7; Naperville, CNHM 19936, 19938, 22050-2, 25979-80, 26301-2, 26303-5, 38702-6; Villa Beach, CA 1420-3; Warrensville, CNHM 38701; West Chicago, CA 2032-3; Wooddale, CNHM 29419, 35760, 35316. Grundy—Diamond, CNHM 35974. *Kankakee* --Pembroke Township, CA 2589. Lake—Barrington, CNHM 23001-5; Beach, CA 1367-70; Briggs Lake, CA 6189; Fox Lake, CNHM 1896; Grass Lake, CA 1803; Lake Zurich, CA 6620; Volo, CA 1836; Waukegan, CNHM 2436; Winnetka, CNHM 22596-635; Wooster, CA 7646; Wooster Lake, CA 7636-45. *LaSalle*—Starved Rock State Park, CA 6028-9. *Madison* UMMZ 46469, 46575, 46588. *McHenry*—CNHM 29201-25, 29278-80, 28206, 29227- 41, 29332-63, 29428-32; Richmond, CNHM 17976-7. *McLean*—Bloomington, CA 2524- 5, UMMZ 27475-6. *Rock Island*—Moline, UMMZ 79225. *St. Charles*—UMMZ 46583- 6. *Wabash* —Mt. Carmel, USNM 12035. *Will*—New Lenox, CA 4310, CNHM 2817; Wheatland Township, CNHM 7455.

INDIANA: Lake—Hesseville, CNHM 4103, 21712; Miller, CNHM 2107; Illinois, CNHM 3355. *Noble*- Wolf Lake, CNHM 21746. Porter—Valparaiso, CA 994. *Vigo*---Honey Creek, USNM 25951. *White*-0.2 mi. s. of White-Pulaski Co. line on Hwy. 43, Collection of S. A. Minton, Jr.

IOWA: Benton—Blairstown, ISC 693. Bremer—Waverly, Frederika, Sumner, RMB. Butler—Dumont, ISC 715; Shell Rock, ISC 815. *Cerro Gordo*—Ventura, ISC 669. *Chickasaw*—Lawler, RMB. Clayton—Strawberry Point, UMMZ 92963. *Delaware*—Manchester, RMB. *Fayette*—west of Strawberry Point, ISC 708. Floyd—Charles City, UMMZ 92945 (2). Grundy—Dike, RMB. *Hamilton*—Stratford, UMMZ 92952. *Hancock*—Forest City, UMMZ 92995. Hardin—Hubbard, ISC 697. *Howard*—Lime Spring, UMMZ 92958. *Jefferson*—Fairfield, UMMZ 92961. *Johnson*—Iowa City, ISC 4756. *Lee*—Keokuk, ISC 292. Linn—Cedar Rapids, Coe College. *Marshall*-State Center, ISC 720. *Muscatine*—Nichols, RMB. *Poweshiek*—Grinnell, ISC 710. Scott—Davenport, RMB. *Story*—Ames, UMMZ 92940 (20), 92941 (30), 92942 (25), 92943 (36). *Tama*---Tama, RMB. *Washington*—West Chester, ISC 700. Worth—Joice, UMMZ 92944 (2). Wright—Solburg, RMB.

MISSOURI: *Buchanan*—St. Joseph, UMMZ 56597. *Chariton*—Sumner, CA 8013, 8028-9, 8031. *Nodaway*—Maryville, CA 8015-7. *St. Charles*—Boschertown, CA 8024-5, 8032-3; Elm Point, CA 8030; Orchard Farm, CA 8014, 8018; St. Peter's, CA 5109-38, 8026-7, UMMZ 46467-8, 46576, 46581-2, 46587, 46599. *St. Louis*—USNM 18814.

OHIO: Marion—OSM 535-9; Greencamp Township, OSM 671. *Wyandot*— Pitt, Township, OSM 667, 670.

WISCONSIN: Dane—Madison, USNM 17423, CNHM 37844; Lake Monona, CNHM 42669. *Green*—New Glarus, UMMZ 64747-8. *Green Lake* —Green Lake, CA 6657. *Kenosha*—New Munster, CA 5453-61; Kenosha, USNM 17416-7. *Milwaukee*—MPM 552, 2518. *Racine*—USNM 719 (Type); Racine, USNM 1044 (11); Corliss, MPM 1505, 1508, 1501, 1503, 1516, 1494, 1499. *Walworth*—Lake Geneva, CA 5079-80; Pell Lake. CNHM 30552.

THE BUTLERI-BRACHYSTOMA COMPLEX

Although Ruthven (1908) accorded *butleri* specific status within the genus, Blanchard (1925, p. 18) regarded it as a subspecies of *radix* in his key. Dr. H. K. Gloyd has checked those notes of Blanchard which are in his possession but can find no information which would indicate the basis for this taxonomic change. Davis (1932, p. 113-118), after a study of the Wisconsin population, regarded *butleri* as a distinct species. Later, in resurrecting *brachystoma*, Smith (1945, p. 147-149) continued to regard *butleri* as a distinct species, as well as *brachystoma*. It now seems necessary to reconsider the status of these two forms, particularly as they relate to the other subspecies, *radix* and *haydenii*.

Scale Rows. Of 237 specimens of *butleri* available, the dorsal scales are arranged in 19-19-17 rows in 228. Four Ohio and three Michigan specimens have 17-19-17 rows; one Ohio specimen has 19-19-17 rows and one Michigan specimen has 17-17-15 rows. The dorsal scales are arranged in 17-17-15 rows in 216 of the 221 specimens of *brachystoma* available; four Pennsylvania specimens having 17-19-17 rows, and one New York specimen 19-19-17 rows. The dorsal scales of 192 (28.5 per cent) of 674 eastern Illinois specimens of *radix* are arranged in 19-19-17 rows. It seems then that in number of scale rows *radix* grades into *butleri*, and there is not a sufficient break in the number of scale rows to warrant full specific rank for *butleri* on this character alone. Although the scale rows are greatly reduced in *brachystoma*, the slight tendency to the higher number of *butleri* is significant, and if sufficient specimens were available, particularly from the eastern Ohio region, the gradual reduction in scale rows between *butleri* and *brachystoma* might be demonstrable.

Ventral Scales. The range of ventrals in 228 specimens of *butleri* is from 129 to 147, mean 139.1 (132-147, mean 140.4, in 124 males, and 129-147, mean 137.9 in 102 females). In 224 specimens of *brachystoma* the ventrals vary from 132 to 146, mean 139.5 (134-146, mean 140, in 117 males, and 132-146, mean 139, in 107 females). There does not seem to be any basis in this character with which to separate *butleri* from *brachystoma*. There are 225 specimens of *radix* from eastern Illinois which have the ventral or subcaudal counts of *butleri*, so that the intergradation of the two forms in these characters seems to be established.

Subcaudal Scales. This is the least indicative character on which to separate either *radix*, *butleri*, or *brachystoma* from each other.

Color. Although more investigation is needed, the change in pattern and color is suggestive of a west to east gradient. The color of the vertebral stripe tends to lessen from the orange-yellowish color of *haydenii* to the very

light-yellowish color of *brachystoma*. The dorsal inter-stripe blotches diminish numerically from *haydenii* to *radix*, and from *radix* to *butleri*; they are reduced both in number and in size. The blotches as such have disappeared in *brachystoma*, in which rarely they coalesce to form a border along the stripes. The ground color also becomes much darker in both *butleri* and *brachystoma*, and in both of these the lateral stripe begins to involve a portion of the second scale row. Consideration of all characters seems to justify the conclusion that *butleri* and *brachystoma* are only partially distinct from each other.

There are specimens of *radix* from eastern Illinois in which various taxonomic characters grade into those associated with *butleri*. There are also 12 specimens of *radix* from this same area in which all characters are so close to those of *butleri* that they might be considered valid *butleri*. This evidence indicates that *butleri* is not sufficiently distinct from *radix* to merit specific rank, and that both *butleri* and *brachystoma* should be considered subspecies of *radix*.

Thamnophis radix butleri (Cope)

Eutaenia butleri, 1889, COPE, Proc. U. S. Nat. Mus., vol. 17, p. 399.

Thamnophis butleri. 1908, RUTHVEN, Bull. U. S. Nat. Mus., no. 61, p. 87; 1932, DAVIS, Copeia, no. 3, p. 113; 1945, SMITH, Proc. Biol. Soc. Washington, vol. 58, p. 147.

Thamnophis radix butleri, 1925, BLANCHARD, Papers, Michigan Acad. Science, Arts, and Letters, vol. 4 (1924), pt. 2, p. 18.

Diagnosis. A garter snake with 19 scales at the neck and midbody, and 17 anterior to the anus; the head is distinct from the neck; the dorsal inter-stripe blotches are reduced numerically and in size. The ventral scales vary from 132 to 147 (mean 140.4) in males, and from 129 to 147 (mean 137.9) in females; the subcaudal scales vary from 57 to 71 (mean 64) in males, and from 51 to 63 (mean 56) in females (see Tables I and II).

Range. This subspecies occurs in glaciated territory in southeastern Wisconsin, Indiana, the eastern half of the lower peninsula of Michigan, Ohio, and southwestern Ontario (Fig. 1, p. 291). So far as known, *T. r. butleri* does not occur in Prairie Peninsula habitats.

In the opinion of the writer, the discontinuity in the geographic range of *butleri*, which has occasioned comment by recent authors, is more apparent than real. This is substantiated by consideration of the following facts: (a) of 674 specimens examined from the intermediate region (Chicago area), 449 are definitely *radix*; (b) of the remaining 225, some have either the scale row count of *butleri* or the ventral or caudal count of *butleri* but in other characteristics are similar to *radix*; (c) of these 225, only 12 are morphologically close enough to *butleri* to be considered *butleri*. These considerations, together with the low number (12) of seemingly valid *butleri* from the Chicago region,

suggest that—taxonomically—it would be better for the present to consider the Chicago region population as *radix* rather than as *radix x butleri*. The figures given above show the numerical prevalence of *radix* in the Chicago region and that the population is in a differentiating condition. The scarcity of specimens of *butleri* from Wisconsin may indicate that *butleri* is gradually being replaced by *radix* in that area, as Davis (1932, p. 116) thought must have happened in the Chicago region.

Thamnophis radix brachystoma (Cope)

Eutaenia brachystoma, 1892, COPE, Amer. Nat., vol. 26, p. 964.

Thamnophis brachystoma, 1945, SMITH, Proc. Biol. Soc. Washington, vol. 58, p. 149.

Diagnosis. A garter snake in which the dorsal scales are reduced to 17 rows throughout; the head is not distinct from the neck; and the dorsal interstripe blotches are greatly reduced or absent. The ventral scales vary from 134 to 146 (mean 140) in males, and from 132 to 146 (mean 139) in females. The subcaudal scales vary from 57 to 72 (mean 67) in males, and from 51 to 64 (mean 59) in females (*see* Tables I and II).

Range. This subspecies occurs in a restricted area within the upper Allegheny River drainage pattern in southwestern New York and northwestern Pennsylvania (Fig. 1, p. 291).

DISCUSSION

It is generally conceded that glaciation has been a factor in the distribution and speciation of the herpetofauna of the northern midwestern area of the United States. Schmidt (1938, p. 401) postulates a *radix-like* form which occupied the central midwest (at least) during the preglacial or interglacial times. The action of the glacier would tend either to isolate or, more probably, to cause a southward migration of many indigenous forms.

The action of the glacier also not only partially but, in some cases, wholly changed the character of the climate, soil, and vegetation; it likewise caused the erection of barriers to the redistribution of many preglacial forms. The prairies which once extended to the Appalachian Mountain area (Fenneman, 1931, p. 616) changed, due to the glacial action, especially in the eastern section, where a prairie-forest transition zone resulted. Thus prairie habitats were isolated either as peninsulae or as islands (Transeau, 1935, p. 423-437). During this same postglacial period, the Great Lakes were formed, thus poisoning a very formidable barrier to the redistribution of many terrestrial poikilotherms. It seems reasonable to explain the diversity and variation of the various subspecies of *Thamnophis radix* as a result of glacial action.

During the glacial era, a *radix-like* form was probably driven southward and westward to a climatic situation more suitable to the survival of the species. This area was most probably a corner of the Kansas-Missouri-Oklahoma-Arkansas section. As glacial conditions changed to a warmer climate, this form began to reinvade its former range, only to meet a variously changed habitat.

The presumably older form, *Thamnophis radix haydenii*, maintained itself fairly close to the probable morphological character of the preglacial *radix*. However, as the reinvasion occurred, there was presented a transition in habitat from the higher and drier plains of the west to the moist prairies of the central region, thence into a prairie-forest transition, and finally forests themselves. In the Chicago area, the presence of Lake Michigan seems to have caused the reinvading form to diverge, one stem northward and the other eastward.

This is exemplified by the morphological closeness of *butleri* to *radix* in Wisconsin. This also seems to me to account for the rather spotty occurrence of *radix* to the east where it occurs in definite prairie islands (Conant *et. al.*, 1945, p. 61-68). It is probable that both the Wisconsin population of *butleri* and the eastern populations of *radix* are disappearing as their habitats in these areas undergo change.

The following key has been tested on 700 specimens, and can effectively separate about 85 per cent of those examined, if used with geographical data.

- | | |
|--|----------------------|
| 1 Lateral stripe on third and fourth scale rows, at least on the anterior half of the body | 2 |
| Lateral stripe encroaching on the second scale row | 3 |
| 2 Scale rows usually 21 at neck; ventrals generally 155 or more | <i>haydenii</i> . |
| Scale rows usually 19 at neck; ventrals generally 154 or less | <i>radix</i> . |
| 3 Scale rows 19 at neck and mid-body | <i>butleri</i> . |
| Scale rows 17 at neck and mid-body | <i>brachystoma</i> . |

SUMMARY

A western subspecies of *Thamnophis radix* Baird and Girard is described to which the name *haydenii* of Kennicott (1860) is applied. This western subspecies is characterized by a higher number of dorsal scales at the neck, and a higher number of ventral and subcaudal scales than are found in the central race, *Thamnophis radix radix*.

The two eastern races, *T. butleri* and *T. brachystoma*, until now regarded as separate species, are considered to be subspecies of *Thamnophis radix radix*. This systematic change is indicated by the presence of definite intergrading

specimens between *radix* and *butleri* and by the similarity of scutellation between *butleri* and *brachystoma*.

The diversity of characters and of size in the four subspecies is considered to be the result of the reinvasion of a habitat changed by glaciation.

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